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COAL MEASURES OF LYON COUNTY.

BY D. S. KELLY, EMPORIA, KANSAS.

Lyon county is situated near the center of the vast region of Kansas known as the Upper Coal Measures, and near the eastern border of the division of these measures sometimes called the Permian strata. This county is as far west as we should expect to find coal outcrops in this latitude. Many attempts were made to find coal in this county before the efforts met with anything like success. About eight years ago borings were made near Emporia which resulted in failure to find coal, except some very thin layers. Along ravines, in various parts of the county, outcrops may be found which show evidences of coal, but not until within the last two or three years have any of these proved workable coal-bearing strata. The first opened which yield coal in any paying quantities are those in the eastern part of the county, near Neosho Rapids, of which mention is made in the State Agricultural Report for 1885.

Within the past year coal has been found at a number of places in the northern part of the county. On the farm of Henry King, eight miles north and two miles east of Emporia, veins nine inches thick have been reported. Near the new town of Admire, recently, on sinking a shaft to the depth of twenty-eight feet, coal of good quality was found to be seventeen inches thick.

For some time past it has been thought that coal existed in paying quantities near Emporia. Four years ago an unsuccessful attempt to find coal was made about three miles to the northwest of Emporia. No further attempts were made in that direction, until a short time ago a company of three men, Wise, Fritz, and Reeves, leased a number of acres a little to the northwest of the place mentioned above. About two months ago they began to drive tunnels into the hill from a ravine, and met with encouraging results. A few days ago I visited these mines, and found that four tunnels had been driven into the hill at short distances apart, the longest one being 175 feet. Nowhere has the vein of workable coal been less than eleven inches. At some places it seems to have been thrown up in folds, where it is seventeen inches thick. The quality of this coal, for some distance in, is about the same as the Fort Scott red coal; then a black coal is reached, which compares favorably in quality to the Osage shaft coal. The men who are in charge of this work are very confident that the enterprise will be a paying one, and expect soon to put a force of thirty or forty men at work.

NOVEMBER 17, 1886.

HISTORICAL SKETCH OF GEOLOGICAL WORK IN THE STATE OF KANSAS.

BY ROBERT HAY, U.S.G.S., AND A. H. THOMPSON, D.D.S.

Being in the center of the continent, touching the great river Missouri, and having within its borders several important tributaries that find their way to that stream or the greater Mississippi, Kansas has been ofttimes on the route of explorers. Some geological features and some of the minerals of its formations have had notice from the earliest times.

In 1724 De Bourgmont, a Frenchman, passed up the Kaw valley, and the very slight notice he makes of mineralogy enables us to see that he saw those glacial boulders which are found in the northeast of the State. His words are (London translation of Du Pratz Hist. of Louisiana, 1763):

"One could observe pieces of rock, even with the ground, . . . and in the meadows a reddish marble standing out of the earth one, two and three feet; some pieces of it upwards of six feet in diameter."

Lewis and Clark, whose expedition passed up the lower part of the Missouri in 1804, besides noticing that this region had limestone in it, only give the further geological information that the bars of the Missouri river had pebbles of pit coal, and that the bluffs of the river were "cliffs of yellow clay."

Major Zebulon Montgomery Pike's expedition, in 1805-6-7, spent much time in Kansas, but gives no geological information, simply referring to reported minerals and salines.

Henry R. Schoolscraft, who spent some time in this Western territory, 1818-19, has this remarkable statement: "Volcanic mountains are reported to exist on the waters of the Kansas."

In 1819-20 Major Long was sent out by the Government, and by his direction Prof. Thomas Say, accompanied by Mr. Jessup, a geologist, was sent through northeastern Kansas to make geological investigations. Mr. Jessup noted the horizontal position of the strata of limestone and their prolific yield of fossils, and their "connection with coal strata." He concluded that the formations were of "secondary" age. This was when the main geologic divisions were known as primary, transition, secondary, tertiary, and alluvial. A map accompanies the report, and a line on it through what are now the counties of Pottawatomie and Wabaunsee is designated as "the western limit of the limestone and coal strata connected with the Ozark mountains." West of this is marked "deep, sandy alluvion," and then, stretching to the mountains, is located the "*Great American Desert.*"

The two expeditions led by Capt. John C. Fremont (1842-3-4) passed up the Kaw, Smoky and Republican valleys. The geological collections were placed in the hands of Prof. James Hall, of New York, who in the report published in 1845 gives figures of some fossils. Some of these, obtained by the expedition on the Smoky Hill river about longitude 98°, are said to be probably of Cretaceous age.

In 1849, Capt. Howard Stansbury located the military road from Fort Leavenworth by way of the Big Blue and Fort Kearney to Salt Lake. Collections of fossils were made in northeast Kansas and west in Nebraska. Prof. Hall reports on those as far as the Blue as belonging to the Upper Carboniferous period. Beyond the Blue, cretaceous rocks were reported.

Capt. Marcy's report (1852) of the expedition to the Red river refers to the existence of gypsum north of the Arkansas river (in Kansas).

Reports on the geology of Missouri give some notice of Kansas formations near the boundary of the two States. That of Prof. G. C. Swallow, in 1855, refers to the position of the Loess on the Missouri river, and also to the similarity of the rock strata on each side of the river where it touches Kansas.

Prof. Swallow and Maj. F. Hawn, in 1858, published an extract from the Transactions of the Academy of Science, under the title of "The Rocks of Kansas." Specimens collected by these gentlemen were sent east, and a paper by Mr. Meek, read at the Albany Institute (N. Y.) the same year, says that some of them were from Permian strata.

A Missouri report, published in 1873, gives observations relating to Kansas from 1855 to 1871, by Prof. Broadhead and Drs. Hayden and Shumard. We shall have occasion to notice further along Prof. Broadhead's later work.

For the foregoing information we are indebted almost entirely to a paper on the "Bibliography of Kansas Geology," read before the Kansas Academy of Science, in 1883, (but not published in the Transactions,) by the able Secretary of the State Historical Society, Hon. F. G. Adams, who has kindly allowed us to use the MS.

Summarizing the items given, we find that at the epoch when Kansas became a State the knowledge of the geological formations within her borders was limited to that contained in the following statements:

1. The Bluff or Loess was conspicuous in the northeast.
2. The Glacial (red) boulders had been observed.
3. The rocks of the eastern part of the State were of Carboniferous age, bearing coal.
4. Permian strata, or rather fossils, had been recognized.
5. Cretaceous formations were believed to be in middle Kansas.
6. Gypsum was reported to exist in the same region.
7. Sandy alluvion plentiful west.

The STATE of Kansas began to do scientific work while it was still young. The organic act, by which in 1861 the Territory became a State, makes provision in advance for important educational facilities. While the civil war was in progress the educational scheme so foreshadowed was put into operation, and the State University, the State Normal College, and the State Agricultural College, were established on what has proved to be an enduring foundation.

During the same period Kansas began by act of the Legislature a GEOLOGICAL SURVEY OF THE STATE. This act became law February 15, 1864. By it the Governor and Senate were to appoint a State Geologist for the term of one year — from March 1, 1864, to March 1, 1865. This State Geologist was "to proceed to classify the rocks and soils of each county;" "to visit and analyze salt springs;" "investigate coal formations, and other mineral deposits, by the appliances known to the departments of geology and mineralogy;" "analyze the soils of the settled counties;" "collect and label a geological cabinet;" and do other things necessary to a thorough survey of the State. The expenditure was not to exceed three thousand five hundred dollars, and it does not appear that the whole of this sum was used. Prof. B. F. Mudge became State Geologist; Major Hawn was designated as Assistant Superintendent of the Survey; Prof. G. C. Swallow, Paleontologist; Tiffin Sinks, M. D., Chemist and Meteorologist; C. A. Logan, M. D., Botanist, and to report on the sanitary relations of the State.

The work of Prof. Mudge and his coadjutors was, of course, limited by the limited means at their disposal. The report of this year's work by Prof. Mudge was not printed till 1866, when it was issued by the State Printer, Hon. John Speer. It is a pamphlet of 56 pages. Considerable attention is given in this report to the items of coal and salt. In connection with the former is given some account of the boring for that mineral which had then begun at Leavenworth, and a geological section of the strata of Leavenworth county is given to a depth of four hundred feet. This section was verified to a remarkable degree by the progress of the shaft, which finally reached coal at a depth of over seven hundred feet. With regard to salt, a full description of Tuthill salt marsh, in Republic county, is given, and references made to other developments of salt brines in wells, streams, and springs. Some of these are compared with the sources of salt utilized in New York and elsewhere, and analyses, methods of manufacture are also given in detail. That advance had been made in the geological classification of rock formations of the State, is seen from the fact that Prof. Mudge recognizes in order the following groups of strata:

1. Coal measures.
2. Permian.
3. Triassic.
4. Cretaceous.
5. Drift.
6. Loess.
7. Alluvium.

It would appear that the development within the State either of the Sub-Carboniferous or of the Tertiary deposits was unknown. In the short notice given to the Cretaceous deposits, which had received very little examination, there is a foreshadowing of what was eventually discovered many years after, that the Kansas Cretaceous system yields true chalk.

In 1865 the Legislature passed another act, which did not limit the time for which the State Geologist should be appointed to one year. It was further an improvement on the former act, in that it authorized an expenditure of $7,500 for the year. Prof. Swallow became State Geologist. Prof. Mudge was not connected with the Survey; the other members were as before. The report published by John Speer at Lawrence in 1866 is an unbound volume of 192 pages. Drs. Logan and Sinks each have reports in it on their several departments, the former discussing the facts of the climate as related to health and various forms of disease, and the latter showing the rainfall and other elements of meteorology as they could at that time be recognized. As the Legislature had prescribed work to be done in each county, this volume has a special report on the geology of Miami county, which gives a section of the formations found therein and investigates questions of petroleum and iron ore as well as coal. Major Hawn contributes to the report notices of eight counties. These are not nearly so full as that of Miami county, which appears to have been pretty thoroughly examined as a typical region of the coal-measure epoch. The counties of which the briefer reports are made are, Brown, Doniphan, Chase, Lyon, Linn, Butler, Osage, and Morris. The Bluff (Loess) is recognized as occurring in the counties of this list which are furthest west, Lyon, Chase, and Morris. It is spoken of also as occurring at the *northwest corner of the State*, in the Republican valley. The rocks of these three counties are described also as permian, and also the strata of Butler county with a slight exception.

The main body of the report of Professor Swallow treats of the formations of Kansas in the following order:

System I. QUATERNARY. *a.* Alluvium. *b.* Bottom prairie. *c.* Bluff. *d.* Drift.

System II. TERTIARY. In western Kansas, but not yet examined.

System III. CRETACEOUS. In central Kansas, only partially examined. Brown, ferruginous, yellow and buff sandstone. Generally classed as Cretaceous, "but saw no proof of age."

System IV. TRIASSIC. Gives these localities: Republican, Smoky Hill and Cottonwood rivers; Gypsum, Turkey and Fancy creeks. Distinguishes ten series of strata (Nos. 2 to 11), and gives a thickness of 338 feet.

System V. PERMIAN. Nos. 12 to 30. Thickness 141 ft. 1 in. Lower Permian, Nos. 31 to 84. Thickness 563 feet.

System VI. CARBONIFEROUS. *a.* Coal measures, 1,647 feet thick. *b.* Lower coal measures, 353 feet. *c.* Lower Carboniferous, 120 feet.

The "coal measures" (*a*) are divided into the following groups or "series," viz.: Upper coal measures, Chocolate Limestone series, Stanton Limestone, Cave Rock, Spring Rock, Well Rock, Marais des Cygnes coal, Pawnee limestone, Fort Scott coal, and Fort Scott marble series.

This report is the last that was issued by State authority. It refers to drawings of sections and lists of fossils that were never published. No further appropriations have been made for this work by the Legislature. We have given some of the details of the work, to indicate what progress had been made, and as a basis of comparison to show succeeding advancement. It were bootless to discuss the reasons for the discontinuance of the survey, as the appropriations were stopped before the report was distributed. When it was issued the work of Professor Swallow was severely criticised by scientists in the East, and it would appear that the report erred in making exact statements where only approximation was possible, and in attempting too much by too rapid exploration in obedience to an unreasoning public demand for immediate economic results.

Had the work commenced by Messrs. Mudge and Swallow been continued until now, a worthy work would have been done. Exactness would have come with time, and the economic value would have been great. This would have been especially so in saving the wasteful expenditure of capital in useless prospecting. Since the date of these reports scores of thousands of dollars have been expended to no purpose in prospecting for coal, where a skilled State geologist would have advised with authority.

Though the State has not directly procured the doing of any more scientific work, yet indirectly she has aided in the diffusion of knowledge of the geological formations within her borders, and advance in definite knowledge has been made by the enthusiasm of individuals. B. F. Mudge became Professor of Geology at the State Agricultural College, and devoted his holidays to making geological explorations and paleontological collections. Later, he collected in the interest of Yale College. Before his death, in 1879, through the published reports of his work the general geology of the northern half of the State, and also that of the southeastern region, became known with a fair amount of certitude. The great features were soon recognized by Prof. Mudge, and his broad experience enabled him at times to give shrewd guesses as to details, that were afterwards verified by actual discovery.

In 1875 Prof. Mudge contributed an article on the geology of western Kansas to the national reports of geological and geographical surveys, made under the charge of Dr. Hayden. In this he recognizes three cretaceous groups, viz., the Dacotah, the Niobrara, and a group between them, which he provisionally named Fort Hays group. He also definitely allotted the Triassic (?) strata of Swallow's report to the Permian below and the Cretaceous above. The Tertiary was classed as Pliocene. This shows that considerable advance had been made in the study of west and mid-Kansas formations.

In the same year Prof. Mudge, as Geologist of the State Board of Agriculture, and in the fourth annual report of that Board, published an article on the geology of Kansas. In the biennial report of that Board for 1877–8 he had also an article on the same subject, which was illustrated with map, drawings and sections. In some points following the line of the articles of 1875, we notice the greater prominence of points of economic importance. The formation in the southeast, which now is yielding abundance of lead and zinc, is described fully, and recognized as belonging to the Keokuk group of the Sub-Carboniferous period, being an extension of that formation from the adjacent lead region of Missouri. The Cretaceous group, formerly called the Fort Hays group, is here recognized as that elsewhere known as the Fort Benton group, and is so named.

Prof. Mudge contributed also many papers on geological subjects (*e.g.*, "Cretaceous Forests and their Migrations," "Bison Latifrons in Kansas," "Geology of the Arkansas") to the annual meetings of the Kansas Academy of Science, but the publications above referred to give most definitely the results of his work and show the advancing knowledge of geology.

Since the death of Prof. Mudge the State Board of Agriculture has employed Prof. Orestes St. John as its Geologist. In the Biennial Report for 1881–2 he gives a very valuable treatise on the geology of the State. The subject is treated with reference to topography, stratigraphy, and economics. The surface formations (quaternary) are more fully discussed, and the drainage is well shown. The report is accompanied by a set of sections and a contour map of the State and adjoining territory. The colored map showing areal development of formations shows advance in knowledge on that of Prof. Mudge in the location of the western limit of the permo-carboniferous formations south of the Arkansas river. Prof. St. John has also in the bulletins and a later report of the State Board contributed an increase of knowledge on the coal region of the southeastern counties, and a paper on the supply of water by artesian wells.

The State Board of Agriculture has in its reports printed many valuable papers on branches of Natural Science, Entomology, Pomology, etc., related to the material advancement of the State. A recent bulletin contained a paper on "The Water Supply of Western Kansas," geologically considered, by Prof. Hay, of Junction City, in which the newly-recognized Tertiary grit (Miocene—Loup Fork) is shown to be an important factor in the distribution and retention of water in the western half of the State.

In 1875 the State Legislature passed a law requiring that to hold the highest grade of certificate teachers of district schools should by examination show that they had at least an elementary knowledge of geology. Though this requirement has since been repealed, it gave an impetus to geological enthusiasm, and paleontological collections began to be made in many schools. By request of State Superintendent Fraser, a small work on Kansas geology was prepared by the late Prof. W. K. Kedzie, of the State Agricultural College. This was published in 1877. It was mainly based on the reports of Prof. Mudge, and recognizes in Kansas the following formations, viz.:

Lower Carboniferous	Keokuk limestone.
Upper Carboniferous	Lower coal measures. Upper coal measures. Permo-carboniferous.
Cretaceous	Dacotah. Niobrara.
Tertiary	Pliocene.
Post Tertiary	Drift. Bluff. Alluvial.

It will be seen that Prof. Mudge's provisionally-named Fort Hays group, afterwards recognized as the Benton, is omitted.

In 1868 the Kansas Natural History Society was organized. It has since become the Kansas Academy of Science. Its members have done original work in botany, entomology, ornithology, archæology, meteorology, mathematics, geology, and paleontology. The reports of its proceedings are printed by the State, under the title of "Transactions of the Kansas Academy of Science." Thus far, then, these reports are official; they are made at the cost of the State, as are those of the State Board of Agriculture, and they are increasing in value year by year, being frequently accompanied by lithographed plates. Prof. Mudge was the first president, and besides contributing many characteristic papers to the proceedings, his geological enthusiasm and genial nature enabled him to give a *geological bias* to the general work of the Academy, the impetus of which is yet felt. Besides those already mentioned, Prof. Mudge contributed many other papers to the Academy, and other members did service directly or indirectly bearing on geological science in Kansas. Joseph Savage, of Lawrence, has had papers on "The Yellow Marl," and the "Sink-Holes in Wabaunsee County." Erasmus Haworth has elaborated the geology of Cherokee county. Robert Hay, of Junction City, has described a small metaphorphic area in

Woodson county, in a paper entitled "The Igneous Rocks of Kansas," and contributed papers on "Fossil Wood" and "The Dacotah Formation." Professors Patrick, Kedzie, Failyer, Bailey, and Willard, have given analyses of minerals and mineral waters. In 1883 the Academy contributed to the expenses of an exploration in the Northwest by Mr. Hay, the results of which were published in the Transactions, under the title of "A Preliminary Report on the Geology of Norton County." In this report the tertiary deposits of the region examined were recognized as belonging to two epochs — the pliocene and miocene — separated by a period of erosion, the lower one being also shown to rest on eroded surfaces of the underlying cretaceous deposits. Papers read at the last meeting (November, 1885) of the Academy, (of which the Transactions are not yet published,) give discoveries south of the Arkansas, showing large development of Jura-triassic strata in Harper, Kingman, Barber, Comanche, and Clark counties, and traces of former extension of tertiary strata as far east as Wichita, and great extension of quaternary formations.

Paleontology has been advanced considerably by the collections of Kansas geologists. Prof. Mudge's name has been attached by eastern authorities, such as Meek and Lesquereux, to new species both faunal and floral. Prof. Mudge also discovered the tracks on the Osage flagstones; and he records in his report as State Geologist, tracks on the sandstones of central Kansas. Frank H. Snow, Professor of Natural History at the State University, and a valued helper of the Academy, has contributed among other papers "Notes," accompanied by a lithograph, on the "Dermal Covering of a Mosasaur," which is in the collection of the University. Professor Patrick reported on the protozoans contained in Kansas chalk. W. Wheeler has given notes on a fossil tusk. Mr. Silas Mason supplied a list of fossils found in Riley county (Permo-Carboniferous). Kansas Cretaceous and Tertiary fossils have by their number and importance served to bring those formations into notice, and eminent eastern paleontologists have not only examined Kansas fossils but employed collectors for long periods to obtain them. Prof. Mudge, Dr. S. W. Williston, and Mr. Charles Sternberg have sent many Mezozoic and Cenozoic fossils to Yale College and elsewhere. Mr. Silas Mason has sent the Philadelphia Academy of Science large quantities of fine specimens of the Dacotah and Carboniferous floras. Professors Meek, Cope, Marsh and Lesquereux have been here and personally examined the horizons which have yielded such abundant illustration of the ancient life. Dr. Hayden has also contributed to the definition of Kansas formations. The State reports of Illinois have been used by Professor St. John as media for describing Kansas paleontological phenomena.

The Kansas City *Review* has been used as a favorite medium for conveying scientific information by scientists of Missouri and Kansas. Professor Broadhead, of the Geological Survey of Missouri, has in its pages several times contributed information about Kansas geology. In one article he narrates an exploration in southern Kansas, in which he defines the western boundary of the coal measures in that region. It is remarkable that his line between the coal measures and the permian is a continuation of the line in northern Kansas given in Long's map, before referred to.

Reports and papers now awaiting publication will alter somewhat the geological map of the southwest of the State, and sections will indicate that there is now recognized an easterly dip in the west part of the State, which is not what was generally thought a few years ago. The following may be taken as the now known order of Kansas strata:

Lower Carboniferous, (Keokuk Limestone,) southeast corner of the State.
Coal measures.
Permo-carboniferous, across the State.

Juro-triassic, from 98° to 101° longitude, south of the Arkansas river.

Cretaceous — three groups, across the State.

Tertiary grit — Miocene, west half of State, mostly on the edge of high prairie and the upper slopes of valleys.

Tertiary marl — Pliocene, west half of the State, mostly on the high prairie land.

Quaternary — Drift, northeast part of State.

Quaternary — Champlain, in isolated areas.

Quaternary — Loess, in eastern half.

Quaternary — Alluvium.

Much remains to be done. The area of 81,000 square miles cannot be thoroughly explored in a quarter of a century by desultory efforts, however enthusiastic. Steady, consecutive work is needed. It is now known that the drift area contains true morainal deposits which await examination, and other Quaternary deposits are claiming the attention not yet given to them. Questions of dynamic geology — upheaval and erosion — faulting and flexure, are pressing forward, and they have all economic value which awaits expression.

In compiling the foregoing sketch, the following material has been used, viz.:

1. Kansas Statutes. Session Laws of 1864.
2. “ “ “ “ “ 1865.
3. First Annual Report on the Geology of Kansas for 1864. B. F. Mudge. 1866.
4. Preliminary Report on the Geological Survey of Kansas for 1865. G. C. Swallow. 1866.
5. United States Geological and Geographical Surveys for 1875.
6. First Biennial Report. State Board of Agriculture. 1877–8.
7. Third “ “ “ “ “ 1881–2.
8. Fourth “ “ “ “ “ 1883–4.
9. Quarterly Reports. “ “ “
10. Transactions of Kansas Academy of Science. 1876.
11. “ “ “ “ 1877–8.
12. “ “ “ “ 1881–2.
13. “ “ “ “ 1883–4.
14. Newspaper reports of Academy meeting for 1885.
15. Agricultural Geology, by W. K. Kedzie. 1877.
16. Articles by Professors O. C. Marsh, E. D. Cope, Leo Lesquereux, and F. B. Meek, in United States Geological and Geographical Surveys, by Dr. Hayden.
17. Geological Survey of Illinois. Vol. VII. 1883.
18. Sundry articles in Kansas City Review.
19. “ “ in American Naturalist.
20. Works of Dana and LeConte.
21. The MS. of F. G. Adams on the Bibliography of Kansas Geology.

[NOTE.—Since the above was written, in June, 1886, the U. S. Geological Survey has printed topographical maps of a square degree in southeastern Kansas, the partial result of the two previous seasons' work by a geographical corps under the direction of Prof. Gannett, the chief topographer of the Survey, and the whole of the season of 1886 having been similarly employed. Topographical maps, on a scale of half an inch to a mile, with contour lines fifty feet apart, are in an advanced stage of preparation for the eastern third of the State.—Also, Prof. Hay was employed during the season of 1886 to work up the geology of the southeast of the State, and his report of a reconnoissance in southwestern Kansas, made in 1885, is now in the hands of the Government printer as a Bulletin of the U. S. Survey.—The new Biennial Report of the State Board of Agriculture (1885–6) has an article by Prof. St. John which shows advance in knowledge of the details of the geology of the southwest of the State. The same volume has an article on the Geology of the Natural Gas of Eastern Kansas, as one of the results of Prof. Hay's work in that region.—R. H.]